FRIDAY MORNING SESSION

JANUARY 23, 1948

The meeting reconvened at nine forty-five o'clock, President Massie presiding.

PRESIDENT MASSIE: The meeting will come to order. The first prepared talk —or I should say series of talks because it is a panel discussion this morning—is on "Education in Photogrammetry." Mr. Tewinkel will preside at that part of the meeting.

Mr. Tewinkel went to school in Washington. Apparently photogrammetry got under his skin and he went to Syracuse to study under Professor Church. He is now at the Coast and Geodetic Survey, and in a comparatively short time has made quite a record for himself and is well known to all of the people here in Washington. At this time I will turn the meeting over to Mr. Tewinkel.

MR. TEWINKEL: Thank you. Mr. President, Members and Guests of the American Society of Photogrammetry: Perhaps the topic of education in photogrammetry has become of such pronounced importance principally because of the lack of it. During the recent War there was much hurrying about and scratching of heads with regard to the principles of using aerial photographs and in the training of personnel in the required procedures. This military and naval activity in photogrammetry, together with the accepted practices of the various mapping agencies, has precipitated a much broader interest in the subject than existed prior to 1941. As a result, many of us are being asked these three basic questions: (1) where can I obtain training in the use of photographs; (2) where can I learn how to teach photogrammetry; and (3) what is the best textbook to use in teaching photogrammetry. I am chagrined with the replies I am forced to give to such inquiries. The September issue of PHOTOGRAMMETRIC ENGINEERING was devoted to the presentation of the problems. (Incidentally, that excellent symposium on education was a product of the Publications Committee under the direction of Mr. P. G. McCurdy: it was not the work of the Committee on Education.) This present discussion is a further step in the emphasis of the subject of education.

A round table discussion is one method of presenting a series of different appraisals of the same subject. One would not expect a participant in such a discussion to present an unbiased opinion. Rather, each of the speakers is expected to give his own *biased* analysis of the problems of education, and you and I are asked to weigh these ideas. We may find that these speakers are very much agreed on certain principles: if they aren't, we may witness some spirited debate. However, the speakers do have a few common characteristics: each is an authoritative professional photogrammetrist who has received his wealth of information through some form of education.

Without further ado, we shall listen to the speakers, the first af whom is Mr. Stephen M. Johnson of the Photographic Interpretation Center, U. S. Navy.

MR. STEPHEN M. JOHNSON: Mr. President, Ladies, and Gentlemen: This paper will deal only with Photogrammetry training as carried on at the U. S. Naval Photographic Interpretation Center, Washington, D. C.

The photogrammetry training at PIC was started in 1944 by four Naval Officers attached to the Photographic Interpretation Center. The training was offered to P. I. officers attached to PIC. I remember very well the morning the officer in charge of PIC called two of us into his office and told us we were going to start a photogrammetry training program, dealing primarily with aerial

photogrammetry. He told us the length of time the course would cover and the date the Navy expected the first class to be ready to go into the field. We drew up what we thought might be a usable program fitting as many subjects as we thought we could teach into the eight weeks we were allotted for the training. Then we started out for some expert advice from people who were engaged in Photogrammetry work around Washington. I remember Mr. McCurdy, Mr. Haney, Mr. Mundine, and other men, gave us invaluable assistance in arranging subject matter and planning the course of instruction. We selected two more officers for instructors and all four of us went ahead with our training. All of this time, while we were working on the schedule and receiving training, we were trying to determine what equipment we would need and round up the necessary material so we would be ready to start operations at the appointed time. When the time did come to start instruction we had wrangled some space, equipment, and four instructors. So the school was under way, but the first class was more or less a case of trial and error. As time went on the course became better, for the instructors became more experienced, and new instructors with more background in photogrammetry were brought in. We were not trying to turn out photogrammetrists as such, for we could not, but we were sending men into the field who had a good appreciation of maps and a knowledge of their development.

This training program continued to the end of the war, the length of the course being extended from eight to ten weeks, thus running on the same overall time schedule as the Photographic Interpretation training program.

Shortly after the cessation of hostilities the Photographic Interpretation Center was reorganized on a Civil Service basis. The center obtained as instructors, former members of all the branches of the service, many of whom had been Naval PI officers. The courses of instruction in photographic interpretation and photogrammetry were extended to fifteen weeks so more time could be spent on subjects being given and new courses added. The instruction to officers of the regular Navy and Marine Corps and a few Army officers was continued.

In the teaching methods now being used at PIC, the staff makes extensive use of visual aids, which we find very helpful in the explanation of subject matter and a great time saver in hours of instruction. We develop visual aids of two types. Most often used is the type of illustration one would place on the blackboard. We have taken many of these diagrams and inked them on the back of four by five foot pieces of oilcloth, then mounted them on a large easel at the front of the classroom. As the visual aids are used they are flipped over to the back of the stand and the next illustration is ready for use. When advisable, small photographic copies of the visual aids are made and given to each student. It was found that even though it took considerable time to prepare the visual aids, it saves many hours of blackboard work during each class, and also presents a more accurate development of the subject matter. The other type of visual aids we develop are models, which we construct af heavy plexi-glass or some similar material. These are used to supplement blackboard drawings and the visual aids described above. Models have been found very useful for problems involving third dimension. We also make use of available movies. For example, two of the special movies used are those sponsored jointly by the Commission on Cartography and the Geological Survey, illustrating Trimetrogon Reconnaissance Mapping, and the Operation of the Multiplex. We use these following lectures, showing only the section of the movie covered in the lecture. It has been our experience that if we show too much of a movie involving technical development without preceding it with a lecture, the students are not apt to

get the full benefit of the movie. We are also developing a collection of 4×5 inch slides illustrating many phases of instruction and courses being taught at PIC. We are developing these from our visual aids and from pictures taken in the classroom illustrating different steps the students perform in their problems.

Our courses of instruction must be presented so that at some later date the student will be able to use his class notes and illustrations by himself. It must be kept in mind that these men we are training are first, Naval Officers, and second, men trained in photogrammetry. Upon completion of their training at PIC, these officers may not use this special knowledge for months or even years, although they might put their new-found knowledge to use the day after they leave PIC. We must remember this as we give our training program, and prepare our courses in such a manner that the student will be able to return to his notes at any time and perform any mapping job assigned to him. If he goes into mapping and planning work directly upon leaving PIC he will be just that much better off. For the above reasons the examinations we give during the course are of the open book type, the primary purpose of the examination being to see if the student can use his notes without the help of the instructor. His notes are useless to him if he cannot put them to use by himself. When he gets on a job, there may not be anyone to question and his notes will be his only source of information. It has happened that the student leaving PIC and reporting to his new station has found that he will be responsible for all map construction and he may have to perform all the jobs himself. Others operate as two or three man teams.

Another thing we must take into consideration is the background of the student. The background of the men in the class is wide and varied. Some of the officer students are very well fitted for photogrammetry having the background afforded by the United States Naval Academy. Others who have come into the regular Navy by other means, have only the minimum background suitable for this work. Thus we often have a very unbalanced class, some students very fast, others very slow. Our lectures must be arranged to make the subject matter easily retainable by the student with a minimum background, but not boring to the fast student.

We are working against time, trying to get as much information as possible into a short period. Often we do not have the time to go into the theory of some of the subjects, since it is necessary that we keep on the practical and production end of photogrammetry. We give the student just enough background material so he will understand enough of why and how to perform his work. We cannot for example, go into the detailed derivation of formulas, but we do show the student how to use the formulas and give references as to where he can find more information on the subject.

At present our instruction is given in block form. By that I mean, one subject is taught for the entire day, $7\frac{1}{4}$ hours a day, until that particular problem has been completed. This way the student pursues one subject, keeping a continuous train of thought until the problem is completed. For example, the problem on Trimetrogon Mapping runs for three to three and one half weeks, depending upon the speed of the class. The daily instruction is broken down into seven periods, four 50 minute periods in the morning with two 50 minute periods and one 70 minute period in the afternoon. This adds up to about 115 hours of continuous instruction on the subject. This type of instruction has both advantages and disadvantages. For the student, it is good in that it carries one train of thought continually all the way through without interruption. This way the subject matter on a long problem is easy to follow and understand. For the

instructor, it is good for it gives him long periods out of the classroom and thus continuous time for research and development of new class problems. On the side of disadvantages, this type of instruction is apt to be wearing on the student, and I know it is wearing on the instructor. The student is apt to get tired of the subject if kept at it too long. To get around this we are trying the experiment of teaching one subject in the morning and another in the afternoon. Thus the instructor is only in the classroom half a day at a time, but for a longer over-all period of time. This gives the student a break from one subject and from looking at the same instructor all day. I cannot say how this will work out for we have not gone far enough to draw any conclusions.

Another thing we must keep in mind when planning our course of instructions is not to have the student become too dependent upon instruments which he will not be able to obtain in the field. As stated before, many of these officers will go out to field positions, and large elaborate instruments will not be available to him. Thus we must stress, and base our instruction primarily upon instruments that he will be using in the field, and mapping methods suitable to field conditions. Throughout the course, the student is introduced and exposed to many instruments he will not find in the field, for we think he should know that the instruments are available, what types of work they will perform and the necessary requirements for operation. There might be a time when the Naval Officer will be located where he will be in charge of the operation of, and production from these instruments, so he should know what they will do for him. As an example, we do not give a great deal of instruction on the multiplex, but spend more time with the stereocomparagraph.

As for the subjects currently being taught at the Photographic Interpretation Center, we are not trying to cover all the field of photogrammetry, but concentrate on the subjects most likely to be used by the student after he leaves PIC. One might say that many of our subjects are taught by request. When students have completed their training and left PIC, we encourage them to keep in contact with us and let us know their problems. We ask them for suggestions as to the course of training; what subjects should be stressed more, ones stressed too much, and any new courses that might be added. Thus knowing the requirements of the men in the field, we try to adapt our course of instruction to best fit their needs. We must keep in mind the requirements of the Navy and present our training program to fit these.

The first two weeks of the course are devoted to Hydrographic Surveying, Projections and Cartography. Here we are indebted to Mr. Medina of the U. S. Naval Hydrographic Office for this period of instruction is given by men sent from that office. This is a decided advantage to the Naval Officer. These men from the Hydrographic Office, a focal point of cartographic information, are in a position to pass on the latest up-to-the-minute material on Hydrographic Surveying, Projections and Cartography. Thus the Naval Officer leaving PIC knows what is being done in cartography now, not what went on a year ago.

During this period of instruction, the student learns to compute and performs layouts of both large and small mercator and polyconic projections, and the military grid. To keep up with the fast moving world the student takes up the study and application of other projections, such as the Transverse Polyconic and Mercator, Gnomonic, Azimuthal Equidistant and others.

Following this study of projections, the student is introduced to the field of cartography. The course is presented in a series of lectures, discussions, demonstrations and class problems designed to give the student a better understanding of maps and charts and to give him a fuller appreciation of their value and use.

At the end of this period the student has an understanding of all the steps required in the preparation of a hydrographic chart. He is also taken on a trip through the Hydrographic Office for a first hand view of chart production on a large scale.

You may ask why we give the student all this work on charts and chart construction, when the Hydrographic Office prepares charts for distribution. For one reason, it gives the officer a much greater appreciation of a chart. There are times in the field when the Naval Officer may have to construct a chart, covering the work from surveying to reproduction. This was often done during the war, where the preliminary chart was prepared in the field for immediate use, and then all the information was sent to the Hydrographic Office where a more complete and finished chart was prepared. Also, the officer may be called in to evaluate an existing chart, or help in the planning of a new one.

Following the study of cartography, the student takes the radial plot and slotted templet method of control extension. This problem is designed to acquaint him with some of the basic and elementary principles of photogrammetry. The student assembles several parallel flights, on a polyconic projection holding to geographic control stations plotted on the projection. From this large plot the student takes an area roughly 36 miles square and prepares a large scale four-color topographic sheet, each student drafting his own set of color separation sheets. At this time the student prepares the black, green and blue sheets.

In the two weeks following the radial plot the student takes up contouring with the Stereocomparagraph. Before contouring the brown sheet to complete his color separation sheets, the student is introduced to the Stereocomparagraph by lecture on the theory, several simple height determination exercises and the use of the correction graph. Upon completion of his brown sheet, all the sheets are assembled, checked and graded by the instructor and the best set sent out for reproduction. The student retains a colored reproduction of the map.

At this point, the student is given brief instruction on the multiplex, so he will know what it is, the necessary requirements for operation, and what results can be expected.

A complete problem in trimetrogon mapping is also given. Each student performs all the steps necessary in the compilation of a small scale planimetric map from trimetrogon photographs. The class turns out one large map, which upon completion is reproduced so each student may retain a copy. Near the end of this problem, the class takes a trip through the trimetrogon Section of the Topographic Branch of the U. S. Geological Survey to see trimetrogon mapping on a large production basis.

The student has now performed all the steps, excluding reproduction, necessary to turn out a large scale map from vertical photographs, and a small scale map from trimetrogon photographs. By performing the work on both types of maps, he has a clearer picture of the amount of detail that should be included in both large and small scale maps. He is in a better position to understand some of the problems involved, as to the detail it is practical to include on maps of different scales and what is the correct map for different jobs.

Following this mapping problem, the class takes up surveying and field astronomy. The surveying problem is designed to acquaint the student with surveying methods, the use of surveying instruments in the field, and some of the problems confronting the surveyor. In this problem, the class, divided into teams, performs its survey on a pre-established closed traverse laid out on the grounds at PIC.

The course in Field Astronomy is designed to give the student a background

in field astronomy and enough actual work and experience so that he could assume charge of a small field party sent out to establish astronomic positions. The student becomes familiar with the operation of the American made transit and T-2 Wild Theodolite. He takes azimuth observations with these instruments and stellar observations using the T-2 Wild Theodolite with the prismatic astrolobe attachment.

Spaced in among the long problems are several short lectures and problems. Among these is a lecture on new photogrammetric techniques and developments. This lecture is usually given by the head of the Photogrammetry Research Division at PIC. This lecture covers as many of the new developments in photogrammetry, military and civilian, as we have information on and are at liberty to discuss.

Also there is a lecture on the geometry of vertical and oblique photographs. Here the student is introduced to tilt, swing and, in the oblique photograph, angles for elevation determination. The analytical approach is taken up as well as the semigraphic methods.

At present we have under development several new courses we think will help to broaden the student's outlook and his scope of photogrammetric knowledge. These courses include optics; evaluation of geographic control, including selection and placing of control stations; electronic photogrammetry to cover some of the work being carried on in shoran, loran, and such new forms of mapping. Also we are developing a new radial plotting and trimetrogon mapping problem. We hope to have both flown in this area, so that the large scale topographic map will be a section of the small scale trimetrogon map. Obtaining photography of the Washington area will make it possible for students to establish control stations in the field, identify this control on the photos, prepare the maps, field check the maps and also air-check them. We believe this will afford as complete a mapping problem as can be offered to any students studying Photogrammetry and Mapping.

MR. TEWINKEL: Thank you, Mr. Johnson, for your remarks on the training program at PIC. Our next speaker is Professor A. O. Quinn, Syracuse University. Mr. Quinn is working with Professor Church in teaching photogrammetry in the Civil Engineering Department of the College of Applied Science at Syracuse University. Professor Church, of course, is very well known in the Society.

Professor Quinn received his education at Syracuse University and later worked for TVA. When the war broke out, he was connected with the United States Navy, also with the Photographic Interpretation Center. Professor Quinn was one of the fortunate individuals who was privileged to be connected with the Bikini operations. His paper will deal with education in photogrammetry from the academic standpoint. Professor Quinn.

PROF. A. O. QUINN: The increased use of aerial photographs as a means of mapping large areas in this country and foreign countries has called for a corresponding enlargement of teaching facilities to accommodate the demand for college graduates to work in photogrammetry. Many engineering colleges for the first time are making plans to include a course in elementary photogrammetry in their civil engineering curriculum, and many other colleges will acquiesce to the requests of former G.I.s who wish to know more about the important tool they learned of during their military careers.

By reason of the tremendous use of maps during the War, more and more people are becoming "map conscious." We should make certain that this consciousness is transmitted to Congressional committees which will insure approval of appropriations for the continuance of current and proposed mapping programs.

Our universities can contribute a great deal in this matter by offering general and elementary courses in Cartography and Photogrammetry which are designed to acquaint all engineers with the science of map-making and the use of maps. In this way, the student who becomes a practicing engineer, knows the value of a good map, and will, in fact, become a most excellent promoter of commercial and governmental mapping programs.

The present problems of the educator are many and include a vast list of uncertainties which considerably complicates the matter of introducing new subjects into an already overloaded college program. Educational trends in engineering are being directed more and more toward a general curriculum composed of social and humanistic courses, as well as the fundamentals of engineering. In general, students are not encouraged to specialize during their undergraduate program. They are guided through more liberal courses with the idea that specialization should come as a part of their graduate work for a Master's Degree.

A most important academic problem at the present time is that of obtaining qualified personnel to teach photogrammetry. Many institutions have not found it practical to employ teachers to give only courses in photogrammetry, surveying and mapping. The result has been that the members of the existing staffs have been asked to review the field of photogrammetry and to prepare courses to be given the following semester. Many instructors, when faced with such a task, have frankly admitted their inability to grasp adequately a teaching knowledge of photogrammetry and have recommended that such courses be held in abeyance until a suitable specialist has been found. Unfortunately, this wise decision has not been followed in every case.

There have been many reasons why photogrammetrists have not entered the teaching profession. The most important has been the matter of low salaries habitually offered by universities. This situation is being rectified and most progressive institutions now realize that they must pay top wages to secure top men to teach and develop outstanding departments. Another drawback for which no immediate solution is apparent is the insistence of educational institutions that their professors be crowned with academic glories in the guise of advanced degrees. In photogrammetry, advanced degrees have been limited to one school, but experience in practical and workable photogrammetry should be given considerable weight in the selection of a candidate for teaching. As stated by Mr. Leon T. Eliel, we need more "emphasis on the *art* of photogrammetry." This art can only be secured through the constant application of fundamental theories.

Industry should encourage employees who have an outstanding talent for teaching to accept such assignments. I know that it is difficult to urge a valuable employee to leave, but as a long range view, wouldn't a number of men trained by this expert at the college level more than replace the original loss? Agencies and organizations using photogrammetry should publicize their work and research problems, preferably through the committees established by the Society, to acquaint teachers and students with the new trends in photogrammetric operations. I have successfully used the various issues of PHOTOGRAMMETRIC ENGINEERING with my students to keep abreast with current ideas. Continued cooperation between employer and teacher will produce greater interest and excellence in graduating students.

An elementary course in photogrammetry does not require a vast capital investment, but in addition to the instructor, the cost of needed equipment is about $1500. This value is based upon a class of 15 and includes three simple

measuring stereoscopes, twelve pocket stereoscopes, two mirror stereoscopes, one mechanical triangulator, miscellaneous drawing and office equipment including a calculating machine, aerial photographs and various dark-room supplies. A dark-room is not essential but is helpful in replenishing photographs used in the course and providing instruction in photographic technique. It also helps to stimulate interest in photography through the creation of a Camera Club.

Aerial cameras and accessory equipment to take photographs will greatly stimulate student work, but unfortunately such ventures are quite expensive. If aerial survey companies would advise nearby colleges when they are preparing to photograph an area, they could be most helpful in showing students this most important phase of the work. Photographs may be obtained for almost every area in the United States at a reasonable cost. The Geological Survey periodically publishes an index map showing the extent of photographic coverage and the agency controlling the photographs.

The symposium in the September issue of PHOTOGRAMMETRIC ENGINEERING has presented some most excellent opinions and plans for education in photogrammetry, and makes an important step in coordinating the needs of industry with the teaching profession. It is hoped that further frank discussions will be conducted by the Society. The September issue also reviews the details of the material usually presented in a course in elementary photogrammetry.

All civil engineers at Syracuse University are required to take the course in elementary photogrammetry, and those who elect to take the option in Higher Surveying and Photogrammetry take 19 credit hours of further work in photogrammetry and surveying. These students also receive the degree of Bachelor of Civil Engineering at the end of four years' successful study.

The advanced courses in aerial photogrammetry which are offered, utilize such special equipment as a comparator, stereocomparator, rectiyfing camera and multiplex. The courses in terrestrial photogrammetry make use of a phototheodolite, photo-goniometer, stereocomparator and dark-room facilities. In order to complete the surveying and mapping program, additional work is given at the six weeks' summer surveying camp, which includes photo-control and photo-interpretation. Geodesy and Astronomy and Least Squares complete the option in Higher Surveying and Mapping now offered by the University.

The time has come when all students in civil engineering and in certain phases of forestry should have at least elementary work in photogrammetry including both field and office procedures. The need for specialized students will continue, but we must be sure not to oversell our product and have available more advanced personnel than can be absorbed by industry. A committee of the Society might well assist interested colleges in gauging the demand for advanced facilities.

It is the policy in many engineering colleges to discuss with each incoming freshman the details of each of the major departments represented in the college in order that the student may choose the branch of engineering best suited to his interests and abilities. I have found that photogrammetry is a new and fascinating possibility to many entering students, and many are anxious to sign up for our photogrammetry option. A careful review of the requirements of industry reveals that every amateur photographer or would-be surveyor will not be a successful photogrammetrist and in-service training can never replace the advantages of a fundamental engineering education. The student in photogrammetry must possess unusual talents. He must be a successful mathematician, particularly in the visualization of spatial analytics; he must be an artist who is

capable of creating from photographs a representation of terrain that is precise, yet pleasing to the eye of the most experienced map user; he must have research ability to further his aims in the new profession of photogrammetry; he must be resourceful and ingenious in dealing with both men and materials; and he must possess a personality and a sense of salesmanship that will promote his ideas and abilities. This, you will say, is a "rare bird," yet it is the type of man that is in demand in photogrammetry. Such a man should be carefully selected and should be given specialized training in his chosen field during his entire college career.

Students are attracted to this work, not through hopes of great wealth, but through a growing realization that it is a profession which is new, fascinating, precise, and ever on the move toward greater perfection. One has only to walk through the many photogrammetric offices here in Washington to gain such an impression.

We have found over a period of years that many of our best students remain in photogrammetry, and I feel that this will be the case in the years to come. I am assured by the leaders of commercial and governmental mapping organizations that the profession needs many more young photogrammetrists to carry on all phases of photogrammetry. There are innumerable additional ways in which aerial and terrestrial photographs may be applied.

There are many ways in which the theories of photogrammetry can be applied to other sciences, and in turn photogrammetry can gain from studies in electronics, optics and mechanics.

At the present time the Society can list approximately 17 colleges that are giving work in photogrammetry either as separate courses or as a part of another course such as surveying. Undoubtedly, there are many other colleges that should be included on this list.

I am sure that the educational institutions are willing to do their full share in the advancement of the science of photogrammetry. Unquestionably, our Universities are the proper places to provide initial and basic training for men who wish to seek professional employment in the field of photogrammetry. Many colleges have already given their facilities and personnel for research work that is directly or indirectly concerned with photogrammetry. Industry should feel free to turn over problems of research to the various university staffs, many of which are equipped with unusual and necessary instruments. In addition to the time and study given to the problem by the faculty, the interest and scientific development of many students will be greatly advanced. Photogrammetry will always need outstanding young men, and it is the problem and desire of the various colleges and universities to prepare our students in the best possible way to assume positions of responsibility in this most fascinating profession.

MR. TEWINKEL: Thank you, Professor Quinn, for your academic remarks. It is surprising that your remarks tend toward the practical. We are glad to hear that, of course.

Talbert Abrams needs no introduction to the Society. He is President of the Abrams Instrument Company and Abrams Aerial Surveys. He finds that nearly every time he sells a stereoscope he must give instruction in its use. So you will find that he is not only an instrument maker but also a teacher.

Mr. Abrams was engaged during the war in training servicemen in the use of photographs in map making. He will give us his ideas from the standpoint of the user of maps and from the industrial side. Mr. Abrams.

MR. TALBERT ABRAMS: Thank you, Mr. Tewinkel. Ladies and gentlemen, you have heard the service side of the needs for photogrammetrically trained

people, and you have heard the academic side and the need for academically trained people. I would like to review the history of photogrammetry for a minute and get back to the grass roots.

I know a great many of the people here, around the country and around the world who are using aerial photographs, I would make an offhand guess that better than 90 per cent of the people who are making their living by looking at photographs never had in mind doing that as a profession when they were taking their formal education. As I look over this room today, I would guess that better than 90 per cent of you finished your formal education more than fourteen years ago, and that was when this Society was first founded. Taking that as a basis, and thinking in terms of those who are using aerial photographs to make maps, I would like to draw this comparison: Few people in the early stages of this business had any idea that they were going to be in this work. At some time or other somebody handed them an aerial photograph. They visualized the possibilities of using that photograph in geological work, highway surveys, mapping for the services, general mapping around the world, making charts and hydrographic charts, and the like.

Most people who go to college have in mind being a doctor or a lawyer or a civil engineer in the very early stages of their training. They make up their minds what they are going to do. But that is not true of a new industry such as we have today.

We have a different problem in training people. We must go back and help the people who are already in photogrammetry, and I would say that there are some fifteen thousand people in the United States today who are making their living just by looking at pictures. Some of them are in the service. Some are in government agencies, but the greater portion are in what I call industry. By industry I mean highway departments, land economic surveys of state conservation departments, city engineers, pipeline engineers, and geologists who use it in a very commercial way. Those are the people that I am thinking about. Somebody has to make a plan so that those people may have better training.

I think that one of the reasons these meetings are so well attended is because you want to learn more about photogrammetry. You want to improve yourselves so that you can do a better job when you go home and also you want to find out what everybody else is doing and how they are using photogrammetry and how you might fit it into your own personal life.

That is why we have a much different approach in industry than in the services or in the universities. Unquestionably we need people trained at the college level who can act as instructors in other schools and colleges. We need people in the services who know all about the various phases of how an aerial photograph can be used. But we also need to go back and help others in some way. Our own company has tried to do that in several different ways.

We have tried to help people by preparing books and pamphlets which may be used as handbooks of instruction. We have tried to teach those who buy our aerial surveys how to use them best and not only for the original purpose intended but all down the line in other departments so that the greatest good is attained.

We have tried to teach people so that they could get the greatest good from what we sold them. Perhaps that is a mercenary approach, but it is a very necessary approach.

During the war we operated a school for the United States Marine Corps. We took young men who were just out of high school, and some had not even completed high school. We also had officers who were the graduates of colleges

and universities around the country, and they needed to have training so they could command the men under them.

Our problem was to teach those people how to make a map from a photograph. We had to show them what was in the photographs, how pictures could be used stereoscopically, how to make different kinds of maps quickly and easily for use in all of the different applications which would be required by a marine. That takes in almost the full gamut of any activity.

We taught those boys a little about surveying; and a little about mathematics, if they needed it; and then we taught them how they could use those photographs. It was a very elementary course. It was not designed to prove to them how smart we were, but designed to show them what they could do themselves.

I think we sometimes get off on the wrong foot when we try to teach people how smart we are. You have to get back to teaching them what they can do, and when you get to that basis you can do a good job.

I do not want to be controversial, but I want to bring that point to your attention. As you go back to your homes, I would like to have you think in terms of the people around you, what you individually, even though you are not an instructor or a professor engaged in education, can do to teach the people around you more about how photogrammetry can be used. I do not want you to think in terms of aerial photographs only, because that is a very small part of what photogrammetry is. Instead I would like to have you teach them and talk to them about how photographs can be measured in the many ways that photographs are used. That takes in photographs made with the optical microscope, with the electron microscopes, with stereoscopic X-ray. It takes in microphotography; it takes in the lofting of large pieces of equipment by photography. There are many other uses for these photographs, and all of that, to me, is photogrammetry. We should try to get those other people into our meetings, and where this meeting almost ends up in being a cartographic meeting, I would like to see you eventually as a nucleus of an organization that can spread to others the idea of measurements from photographs and create an interest in the schools. Even the high school level is a good place to start. Get it into our technical schools below the college level, then into our colleges wherever you can and see if they cannot help by training people who can teach in the higher grades to better advantage.

We need people who can design instruments, because there are many instruments yet to be designed. We need people who can create, and only with a good basic understanding, can we get those people, and the more we can help along those lines, the faster the general acceptance of photogrammetry will be felt.

I have covered quite a few things. I have kept it on a lower level than both of my compatriots on the panel, but I have done it for a very definite reason. I hope you will think about it in those terms. Thank you very much.

MR. TEWINKEL: Thank you, Mr. Abrams, for your excellent remarks. We were very glad to hear this side of the problem. Mr. Sawchuk, ladies and gentlemen, is a member of the Civil Service Commission. He is on the Advisory Staff on Engineering. We thought since many of you are connected in Federal photogrammetry and mapping agencies, you would be happy to hear a few remarks from his standpoint. Mr. Sawchuk.

MR. SAWCHUK: Thank you, Mr. Tewinkel. I do not have a prepared speech. My only observations are these: The Civil Service Commission, of course, is engaged in one business, and that is to furnish to the various governmental agencies, talent for the various activities in which they are interested and in which they are currently engaged.

We, of course, recognize that there is a very distinct and definite need for talent in the Federal service for qualified personnel to perform work in field surveys and photogrammetry.

It is improper for the Civil Service Commission to promote any particular type of education inasmuch as there is also a need for other types of talent in the Federal service, such as paleontologists, tax economists, and what not. However, we are certainly very keenly aware of the fact that there is a distinct need for people well trained in the field of photogrammetry. It certainly would facilitate our job; it would facilitate the jobs of the various governmental agencies if they could secure better trained personnel for their specialized work.

There is very little that I can say other than that in our job of recruiting and assisting the agencies in recruiting talent for such work, we certainly give every possible consideration to all kinds of qualifications which a man might show for entering into that particular specialized field. We like to evaluate a man's background regardless of whether it is acquired in the military service or in a civilian capacity. We certainly attempt to give every possible consideration to the knowledges and skills which that person has acquired and assign a corresponding rating, depending on the talents which he demonstrates he has acquired.

Other than that, there is little I can say, except that we are keenly aware of the need for such talent. We are anxious to see what can be done about giving the governmental agencies the kind of service they need in order to prosecute more effectively their programs in the field of photogrammetry.

MR. TEWINKEL: Thank you very much, Mr. Sawchuk.

We have some time for a few questions from the floor. If you have a question, please rise and identify yourself and direct your question to one of the speakers of the forum.

PROFESSOR PHILIP KISSAM (Princeton University): How long is that course? I did not catch how many weeks your course was at PIC.

MR. JOHNSON: The training course at PIC is fifteen weeks long.

MR. PHILIP G. MCCURDY (U. S. Hydrographic Office): Isn't it true that you have trouble in getting trained photogrammetrists in the Federal service?

MR. SAWCHUK: The answer is yes. We have attempted to do our utmost, of course, to recruit candidates who are qualified to perform such duties, and we have encountered considerable difficulty. The great difficulty is largely at the lower levels where the vast bulk of work is ordinarily performed in the various laboratories and offices.

MR. SAMUEL THORNE, JR. (Free Lance): Mr. Sawchuk, it might be pertinent at this point to mention what the range of ratings is in the Government service to people in the photogrammetric field.

MR. SAWCHUK: That question is a little off the beaten path. It does not directly concern education for photogrammetry, but I can answer it quickly. In the Federal service, photogrammetrists are employed in just about the entire gamut of Federal positions, starting from the lowest position to the highest professional position.

We have a very distinct and difficult problem, because, during the war, a great number of persons were employed in the field of photogrammetry in highly specialized jobs.

Photogrammetry by its nature, can be subdivided into various component parts, and individuals can be highly skilled in any one of these without acquiring the fundamental or broad knowledge required for a good comprehensive understanding of the science itself. Consequently, the individuals who became skilled

in the component parts are generally performing work in the subprofessional categories.

The subprofessional levels range from the 3 grade up to the subprofessional 8, pay from $1700 to $3000 a year.

In addition, we have professional talent engaged in the field of photogrammetry, and their salaries range anywhere from $2600 to $10,000 a year. Of course, you can appreciate that the people in the professional categories are entrusted with considerable supervisory responsibility, with considerable technical work and with the more complex projects.

(Editor's Note: The following statement was received from Robert F. Thurrell, Geological Survey, subsequent to Mr. Sawchuk's remarks.)

"Mr. Sawchuk conveys the impression that little opportuity exists for photogrammetrists in professional status with the Federal Government. Actually the need for personnel during the war forced the subdivision of processes to create sub-professional positions. Proposed reorganizations are attempting to counteract this situation." The reader's attention is directed to page 181 of this number where the report of the Society's Civil Service Committee is printed in its entirety.

MR. MCCURDY: I think the gentleman's question had quite a bearing on this subject of education. I think it helps if the heads of universities tell the students entering the schools what possibilities there are for them.

I would like to ask Professor Quinn if he thinks it desirable either now or in the future, for engineering schools to offer degrees in photogrammetry or in specialized mapping.

MR. TEWINKEL: The question is directed to Professor Quinn.

PROFESSOR QUINN: That particular subject has been one of great debate in our minds at Syracuse, as it must have been in the minds of a great many other universities. We think not. We think that a man with a degree of bachelor of civil engineering is much to be preferred over a man who is much more highly specialized, to obtain a degree as, say, bachelor of photogrammetry.

I do not feel that the demands of industry at the present time are sufficiently great to warrant a man going into the very narrow specialization that would be necessary in order to give him a degree strictly in photogrammetry. We have found that photogrammetry is a very definite means to an end, in surveying and mapping work, but I do not feel at the present time that it is sufficiently in demand to warrant a college giving a degree in photogrammetry as such, without giving a man specialized training in civil engineering along with the photogrammetric training they can now get at some of the universities.

MR. F. L. WILLS: (Hunting Aerosurveys). I wonder whether the Professor has thought, as we do in England, of giving an honor certificate or a diploma in photogrammetry under your bachelor degree. You could make it a diploma of honor.

PROFESSOR QUINN: The way we do that now is that when a man graduates from Syracuse and obtains a degree of bachelor of civil engineering, he is also afforded the privilege of saying that he has a degree of bachelor of civil engineering with the option of higher surveying and photogrammetry.

We do not make it officially an honorary diploma, but it is something additional that our graduate in photogrammetry can have over and above the fact that he is a bachelor of civil engineering.

COMMANDER O. S. READING (U. S. Coast and Geodetic Survey): I would like to ask if the visual aids described in the PIC course could be made available to other colleges and schools. It strikes me that they are doing a lot of fine work

and if these aids could be made available for the professors who are interested in elementary courses, it would save much work.

MR. JOHNSON: The visual aids that we have prepared so far have been made only in single copies. We have only the originals used in the classroom. As to whether we could make them available to the public or not I cannot say.

MR. DAVIDSON (U. S. Geological Survey): There is a wide gap, apparently between the suggestion Mr. McCurdy made regarding a degree in photogrammetry and the attitude of the colleges, as expressed here today.

It might be of interest that General Wang, who has visited here and who is one of the very highly rated instructors in China, was surprised to find out that we did not have a degree in cartography in this country, that most of our map making professionals were civil engineering graduates and they have to cover the broad field which that entails.

It might be that cartography, which would include all types of surveying and geodesy as well as photogrammetry, could be the middle ground between a degree in photogrammetry and a degree in civil engineering.

MR. TEWINKEL: Are there any remarks?

PROFESSOR QUINN: I saw the way Mr. Davidson looked at me. I think he wants me to get in on that.

I still go by what I said before. I do not think we are in a position where we want to have a specialized degree in either cartography or photogrammetry. I think the field can be adequately covered by a general plan in the civil engineering curriculum that might be given to warrant a man receiving a degree of bachelor of civil engineering.

MR. MARSHALL WRIGHT (Department of Agriculture): I have no question to ask, but I would like to make an observation. In my association with the graduate school of the Department of Agriculture, it might be interesting to know that we have twice as many students taking surveying and mapping courses as all of the other engineering courses together. That has prompted the director of the graduate school to ask whether it might be desirable to give a course next year which would lead to a certificate comparable to a master's degree in surveying and mapping. I am not putting in a commercial plug for the school, but we now have a committee—Mr. Tewinkel is a member —and are drafting the curricula of a course, probably to be given next September, which will outline approximately a thirty-hour credit course. This may take $2\frac{1}{2}$ years to complete, giving geodesy, cartography, astronomy, elementary photogrammetry, and advanced photogrammetry.

I think that is an indication that the schools haven't given those things proper attention and consideration, and that there is a great need, particularly in the Federal service, for this additional training. It is evidenced by the great number of students taking these courses, which we hope to combine in one course giving them a master's certificate.

The graduate school cannot issue a diploma, but it will give a master's certificate which will be recognized by the Civil Service and by other agencies.

MR. TEWINKEL: It might be mentioned that the graduate school of the Department of Agriculture is somewhat independent from the government services, but it offers night school courses for training in various subjects of both undergraduate and graduate level.

MR. H. L. CAMERON (Department of Geology, Acadia University, Norville, N. S., Canada): I would like to ask what qualifications a professor should obtain who wishes to set up a course in photogrammetry, or who has been requested to do so. Also where can he obtain within a year the necessary qualifications to

give such a course? If already a professional man, should he take a complete course in photogrammetry? Should he indulge in a tour with one of the commercial companies, or what course should he pursue? I believe Professor Quinn could answer that.

PROFESSOR QUINN: Of course, this will be somewhat of a biased conclusion, as you might suspect. I can say this: We have a great many students from foreign countries who have in mind some of the ideas you mention. They want to return to their particular countries with the idea of either working in or teaching photogrammetry. The thing that most of them have done with some degree of success is this: we can give them a master's degree at Syracuse. This is obtained by taking particular courses in the regular higher surveying and photogrammetry option. In addition, a great many of them have found it desirable to come to one of the agencies in Washington for a short period of time in order to see a bit more about photogrammetry in actual operation, and I think some of these agencies—Mr. Tewinkel knows better than I—are very anxious to cooperate with these particular people.

I think you mentioned that there were some people from South America with the Coast and Geodetic Survey at the present time, and I think that that is more or less common here in Washington.

Forgetting the basic theories and fundamentals, it seems to me advisable to go to a college and then perhaps join an organization temporarily with the idea of becoming familiar with the various types of operations.

MR. TEWINKEL: Mr. Quinn might have mentioned also that not only the Coast and Geodetic Survey but the Geological Survey and the Army Map Service are cooperating in this particular operation, and have several students, or trainees, from foreign countries carrying out these educational programs in photogrammetry, cartography and map making.

MR. JANUSZ J. KLAWE (University of Toronto, Toronto, Canada): Mr. Chairman, I do not have a specific question that I wanted to ask, but from today's panel, as I understand it, we have three different questions. Mr. Johnson was dealing with people in an emergency state, where the Navy, or others, have needed people trained in photogrammetry to do certain jobs. Mr. Abrams found similar conditions in industry and in his professional work. Technical personnel needed to be trained to use his instruments. Professor Quinn, of course, presented an academic point of view.

My suggestion would be that this Society, which represents all branches of photogrammetry, that means commercial, government and academic, set up a committee to plan or suggest the future education of people employed in professional photogrammetry, because we understand very well that in photogrammetry we always will need people with an academic education, to mention only the teaching staff, but we, at the same time, need many technically trained people who do not need special academic, expensive and long education. Would it not be wise to set up some kind of a committee, having those two purposes in mind?

You have Professor Quinn on one side, who would like to train engineers in specialized photogrammetry, which I think is a very wise idea, because civil engineering and surveying should have a branch of photogrammetry now. On the other side we have education which is helpful to other professions, like forestry, where they have use for photogrammetry. In between is the technical personnel who will operate photogrammetric instruments, taking photographs, and so forth, and they would be helped by that special education.

MR. TEWINKEL: Thank you sir. Do you have any remarks on that, Mr. Abrams?

MR. ABRAMS: In my original remarks I made the statement that about 90 per cent of the people who were using aerial photographs, who make maps, or who inspect them or interpret them never went to school to study that subject, and I think that is just about right. I know that 90 per cent of the people is a great majority of the number interested in this profession. Only 10 per cent will probably ever have formal training.

There have been trained in the United States, in colleges and universities, a few hundred people who have made a specialty of studying the subject of photogrammetry in its entirety, but here is the other 90 per cent who have not had that opportunity. Something has to be done to help them. For example, our company has opened several schools around the country in an effort to do that. We went into areas like Mississippi, and in cooperation with the Mississippi Highway Department we opened a school.

We let them invite in the highway engineers, principally, and the locating engineers from the adjoining states. The state highway department would sponsor that meeting. We would, in a period of one week, show them what aerial photography was, how to study it stereoscopically and how to make several kinds of maps from those photographs.

That is really very elementary and we know it, but, for example, here is a group of graduate engineers. Probably the majority of them are civil engineers, and we must train them so that they can go back to their jobs. They cannot be spared for more than a week or so, and we try to give the training in that period of time. More schools of that kind all over the country and around the world would help out this program. Does that answer your question, Mr. Tewinkel?

MR. TEWINKEL: I think it does. Thank you very much.

Our time has drawn to a close. I know we have not covered the subject completely, and there are many good ideas from the floor. It is suggested that if you wish—and we encourage you to do so—to write these ideas and submit them to the Society and they will be incorporated in the published proceedings of this meeting along with those that have been submitted from the floor.

Perhaps we might conclude from these remarks a number of things, among them, of course, is that we recognize the lack of education, and we have seen that there are at least three different approaches to the problem of training in photogrammetry, none of which has been thoroughly taken up or accomplished so far. With that, the panel is closed.

PRESIDENT MASSIE: Mr. Tewinkel, I would like to thank you for the able handling of the panel this morning. Our next speaker, Mr. V. R. Short, has been connected with the museum at Yale and also the museum in New York City. He is now connected with the Sikorsky Aircraft Division of the United Aircraft Corporation and has been for some time. It is with great pleasure that I present to you Mr. Short who will talk on "Sikorsky Helicopters—the Flying Tripods."

MR. SHORT: In this article we point out the various problems involved in using the helicopter as a flying tripod and illustrate some of the preliminary results with the hope that the specialists in the various phases of photogrammetry will carry on from here and show us what a fine job can be done. As most of you know, a successful practical helicopter is scarcely eight years old and through the acceleration of the war effort, the Sikorsky type has amassed some sixty thousand hours of flight experience devoted mostly to rescue, reconnaissance and other military uses. As the commercial types were first released from the production lines early in 1946, even our engineers and sales department could not have dreamed up the inexhaustible list of suggested uses and ideas that poured into our edifice for various uses of the helicopter. One of the frequent inquiries was in connection with the use of the helicopter for various types of